

A DISCRETE MANUFACTURING STUDY

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A DISCRETE MANUFACTURING INDUSTRY STUDY

Prepared for:

Honeywell, Inc.

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July 14, 1978

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TABLE OF CONTENTS

	<u>Page</u>
I INTRODUCTION	1
A. Purpose	1
B. Research And Methodology	2
II EXECUTIVE SUMMARY	3
A. Conclusions	3
B. Recommendations	5
III RESULTS OF THE USER INTERVIEWS	10
A. Industry Identification	10
B. Respondent Profiles	10
C. Description Of The Business As It Relates To Manufacturing	12
D. Manufacturing Planning And Data Collection Methods	20
E. Evaluation Of HMS-80 Product Concept	23
F. Users' Evaluation Of Product Options	27
G. Product Evaluation And Selection Procedure	32
H. Respondents' Reactions Towards Plant Engineering Or CAD/CAM Systems	37
I. Manufacturing Planning And Control Investment Alternatives	37
J. Evaluation Of Potential Vendors	41
IV MARKET PROJECTIONS FOR PLANT MANAGEMENT AND CONTROL SYSTEMS (U.S. ONLY)	43
A. Determining Market Potential	43
B. Calculating Market Penetration	45
APPENDIX A: COMPANIES INTERVIEWED	47
APPENDIX B: USER QUESTIONNAIRE (Revised 5/12/78)	49
APPENDIX C: SIC CODE INDUSTRY CLASSIFICATIONS	71

LIST OF EXHIBITS

		<u>Page</u>
II	-1 Manufacturing Control Requirements	8
III	-1 Interviews Conducted	11
	-2 Total Part Numbers Per Establishment As Reported By Respondents	13
	-3 Government Contract And Configuration Control Requirements As Reported By Respondents	14
	-4 Cost Of Carrying Inventory As Reported By Respondents	15
	-5 Inventory Breakdown As Reported By Respondents	17
	-6 Relative Importance - Manufacturing "Hot Buttons"	18
	-7 Manufacturing "Hot Buttons"	19
	-8 Frequency Of Updating Status Requirements For Key Activities As Reported By Respondents	21
	-9 Planning And Control Systems Installed	22
	-10 Which Of The Following Techniques Do You Use To Collect Data From Manufacturing And What Type Of Data Is Collected?	24
	-11 Relative Importance - Evaluation Of HMS-80 Principal Features By Respondents	25
	-12 Evaluation Of HMS-80 By Respondents	26
	-13 Comparison Of Respondent Propensity Groups Toward Acceptance Of HMS-80	28
	-14 Relative Importance - Evaluation Of HMS-80 Management Tool	29
	-15 The Importance Of The Respondent Of The Following HMS-80 Features	30
	-16 Preferred Methods For Receiving Data Output At Specified Prices As Reported By Respondents	31
	-17 Preferred Status Reporting/Inquiry Capabilities As Reported By Respondents	33
	-18 Preferences For Applications Development As Reported By Respondents	34
	-19 Vendor System Installation And Maintenance	35
	-20 Who Was Or Would Be Involved In The Product Evaluation?	36
	-21 Respondent Presently Has Or Will Probably Install Following Systems In 2 And 5 Year Period	38

I INTRODUCTION

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A. PURPOSE

- It is the intent of this study to determine the attitude of potential discrete manufacturing users towards the HMS-80 as it relates to:
 - The relative importance of various product features or capabilities.
 - Product price sensitivity.
 - Comparison with alternative product offerings.
 - Characteristics of the respondent's establishment.
 - The product evaluation and justification procedure.
 - Engineering interface requirements and plans.
- Determine the HMS-80 product's purchase probabilities.
- Forecast the potential market size for plant management and control systems.

B. RESEARCH AND METHODOLOGY

- The research for this study consisted of conducting 57 in-depth interviews of establishments contained within SIC codes provided by Honeywell.
- Supplemental work was completed utilizing other sources as deemed by INPUT to be appropriate for purposes of cross checking information collected during the interview cycle.

II EXECUTIVE SUMMARY

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A. CONCLUSIONS

- Manufacturing management is becoming significantly more familiar with the use of computer technology and has had frustrations in relegating planning and control responsibilities totally to the data processing or finance functions.
- There is an increasing awareness within manufacturing management of the possibilities and values of on-line data collection techniques.
- INPUT believes there is a greater potential for the "communications highway" than perceived by respondents. Interoffice and departmental communications offer opportunities external to the responsibilities of the production or materials executive.
- There is no definite trend towards a particular SIC group being a more highly qualified HMS-80 prospect.
- Most respondents reported that over 50% of part numbers being used within the establishment were being purchased.
- In general, respondents appeared to be knowledgeable about both their company's product offerings as well as the functional requirements of their jobs.

- Of those interviewed, about 45% of inventory investment was in purchased parts and raw material, 40% work in process, and 15% in finished goods.
- "Tracking of work in process" and "production scheduling" were the key manufacturing "hot buttons" reported by respondents.
- About two-thirds of respondents who have had manufacturing control systems installed since 1973 are concentrated on planning, which precede scheduling and status reporting systems.
- Prepunched "travelers" are primarily used for the collection and input of manufacturing data, 85% of which must be entered on an on-line, per shift or daily basis.
- Relating to the principal features of the HMS-80, respondents do not perceive new technology in the product, but agree with the display selections and product specifications except for the telecommunications interfacing with other automation activities such as CNC or CAD which were rated low on importance evaluation. Of particular interest were:
 - Status reporting.
 - Easy interface with upstream planning systems.
 - Intra/inter-department communications.
- Further confirmation of the product concept as perceived by interviewees is reflected by their indication of an attractive standalone unit price of \$45-50,000 with an expected purchase (70% or better probability) in the 24-36 month time frame.

- Respondents consider tabular reports on a CRT terminal as the preferred method (based on price/performance) for receiving data output.
- Users seem to want the flexibility for modifying the format for status reporting, as reflected by their desire to be able to change such a display on a "one-time" basis. In addition, respondents prefer vendors to supply application software development as well as modifications and enhancements, although "one stop shopping" is not demanded.
- The materials (production control) manager or EDP manager is the key executive involved in the product initiation and justification procedure. Final approval is with the ranking establishment executive, frequently a corporate officer, and will be based largely upon lead time and/or inventory reductions.
- Little enthusiasm was registered by respondents for plant engineering, CAD/CAM or other non-material control applications to be incorporated within the system.
- Honeywell was ranked second to IBM as a potential vendor of plant management and control systems, according to respondents. There apparently exists a strong association towards controls and automation capabilities as being resident within the Honeywell organization.
- There is a growing market for plant management and control systems, with Hewlett-Packard and DEC developing most user awareness.

B. RECOMMENDATIONS

- Provide product that can interface with the materials requirement planning system installed at the establishment which may ultimately require communicating with an IBM mainframe.

- Plan for product justification on a total system basis, but install one at a time.
- Initially, market to companies:
 - Having familiarity with Honeywell.
 - Having multiple establishments.
 - Understanding the need for diminishing manufacturing throughput time.
 - Employing knowledgeable professionals in the materials function.
 - With MRP installed and working.
- Consider developing a "purchasing machine."
 - From purchase, fabrication or assembly request for order, through receiving, inspection or accounts payable.
 - Production planning and scheduling and stockout anticipation.
 - Substantiate product purchase on inventory and lead time savings.
 - A simple concept relative to the complexity of the manufacturing functions.
 - No industry/sub-industry (SIC) barriers.
 - All purchase orders include similar legal payment terms.
 - Clearly define the product offering and interface with MRP and master scheduling.
- Evaluate an integrated product to be installed on an incremental basis:

- Fabrication or purchase orders for parts always reflect actual issue and required completion dates. Operations with either the establishment's fab shop or vendor can be scheduled and status reported on a per operation basis.
- A common receiving department function is created for either purchased or in-house fabricated parts.
- A central stocking area transfers all parts via conveyerization to the required sub-assembly or assembly department which operates on a scheduled basis.
- Status reporting monitors both final assembly and inspection as well as shipping functions.

III RESULTS OF THE USER INTERVIEWS

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A. INDUSTRY IDENTIFICATION

- Exhibit III-1 shows the breakdown of the 57 interviews conducted. SIC groups, provided by Honeywell, represented:
 - Interviews in the "high propensity" (as identified by Honeywell) and in the "low propensity" groups.
 - "Other" comprised the initial interview test group.
- Results of interviews conducted revealed no perceptible trend towards the "high propensity" group being more highly qualified prospective HMS-80 buyers than other respondents.

B. RESPONDENT PROFILES

- Interviewee titles ranged from "Plant Manager" or "VP Manufacturing" in a small establishment to "Materials Supervisor" in a larger organization. Some examples are:

EXHIBIT III-1

INTERVIEWS CONDUCTED

NUMBER OF INTERVIEWS	S.I.C. (BY PROPENSITY)			EMPLOYEES / ESTABLISHMENTS				
	HIGH	LOW	OTHER	<500	500- 999	1000- 1999	2000- 2999	>3000
6		3429		1	1	1	1	2
1			3433	1				
3		3452		2	1			
3		3494			2	1		
1			3523		1			
2	3531			1	1			
1	3532				1			
2	3533				2			
1	3535				1			
1			3546				1	
1	3551				1			
1	3559				1			
1			3562	1				
1			3563			1		
4	3621				3	1		
1		3631			1			
1		3632				1		
1		3639				1		
3			3661		2	1		
10	3662			3	1	4	1	1
7	3679			1	2	4		
1	3721							1
4	3728			1	1	2		
57	34	15	8	11	22	17	3	4

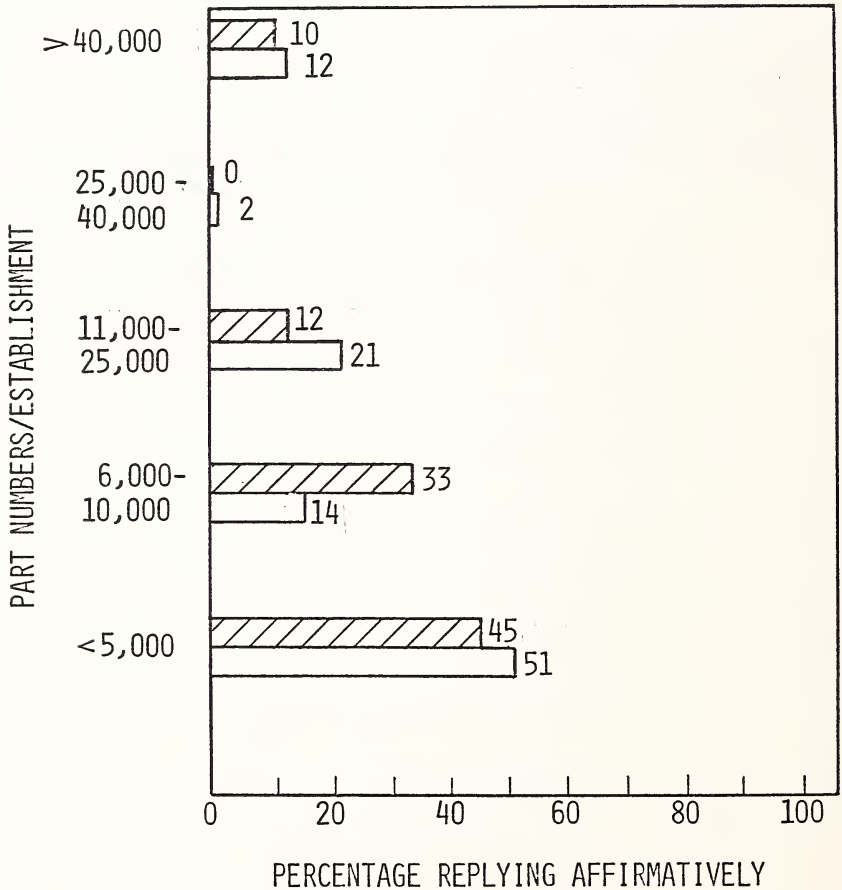
- Production Control Supervisor.
- Inventory Control Manager.
- Materials Manager.
- Production Scheduling Manager

C. DESCRIPTION OF THE BUSINESS AS IT RELATES TO MANUFACTURING

- The number of employees per establishment varied from 300 to 3,700. As expected, the area of the establishment varied accordingly within industry groupings with an average of 390 square feet/employee.
- A great variety of products existed among respondents, from nuts and bolts (3452) to aircraft (3721).
- The overall relative percentage of purchased versus fabricated parts was skewed towards "high propensity" (SIC) establishments.
- Exhibit III-2 shows the swings of purchase/fabricated mix as reported by respondents of various establishment sizes. The average number of part numbers per establishment reporting was about 17,000.
- Over 50% of respondents reported working on government contracts and approximately 75% maintain product configuration control (Exhibit III-3). In overlaying these findings on the analysis of Exhibit III-4, where 70% of respondents calculate the cost of carrying inventory to be from 16-25%:

EXHIBIT III-2

TOTAL PART NUMBERS PER ESTABLISHMENTS
AS REPORTED BY RESPONDENTS
(51 RESPONSES)



☐ PURCHASED
☒ FABRICATED

EXHIBIT III-3

GOVERNMENT CONTRACT AND CONFIGURATION CONTROL REQUIREMENTS AS REPORTED BY RESPONDENTS (52 RESPONSES)

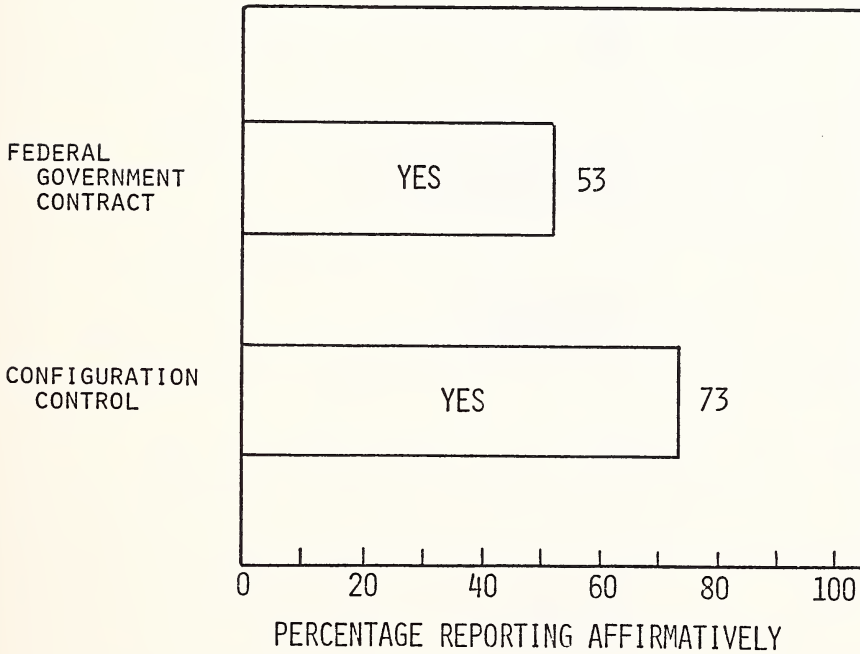
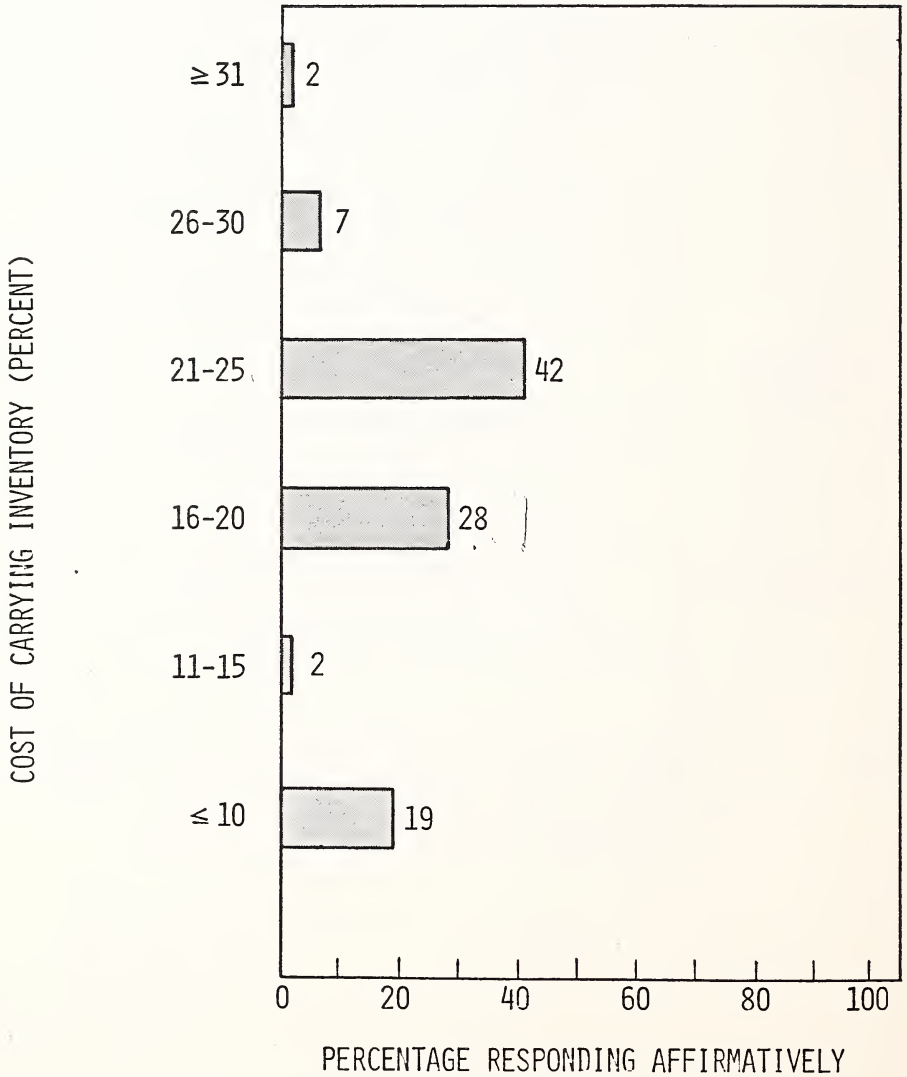


EXHIBIT III-4

COST OF CARRYING
INVENTORY AS REPORTED BY RESPONDENTS
(43 RESPONSES)



- Establishments with 90% plus government business report an average 14% inventory carrying cost versus 20% for those having less than 10% government business.
- When government contracts provide the inventory investment, there is every reason for stocking all part inventories with the utmost dispatch.
- When analyzing the inventory split between purchased parts, raw material, work in process and finished goods (Exhibit III-5), the following findings emerged:
 - Overall, respondents reported approximately 40% of inventory in purchased parts/raw material, 45% in work in process, and 15% in finished goods.
 - Most of the establishments did little finished goods warehousing, with over 50% reporting an investment of less than 15% of total inventory.
 - The sample interviewed reported a relatively high dependency of material flow upon the efforts of purchasing.
- When asked to rate manufacturing "hot buttons" as perceived by the respondents in their industry, the results are reported in Exhibit III-6 and III-7:
 - Work in process tracking received the highest score with 73% of respondents rating it "1" on a scale of 5.
 - Production scheduling ranks second in importance, followed by end product requirement forecasting.
 - Government oriented industries place high priorities on tools for the measurement of variances to plan for time and cost of production schedules.

EXHIBIT III-5

INVENTORY BREAKDOWN AS REPORTED BY RESPONDENTS (48 RESPONSES)

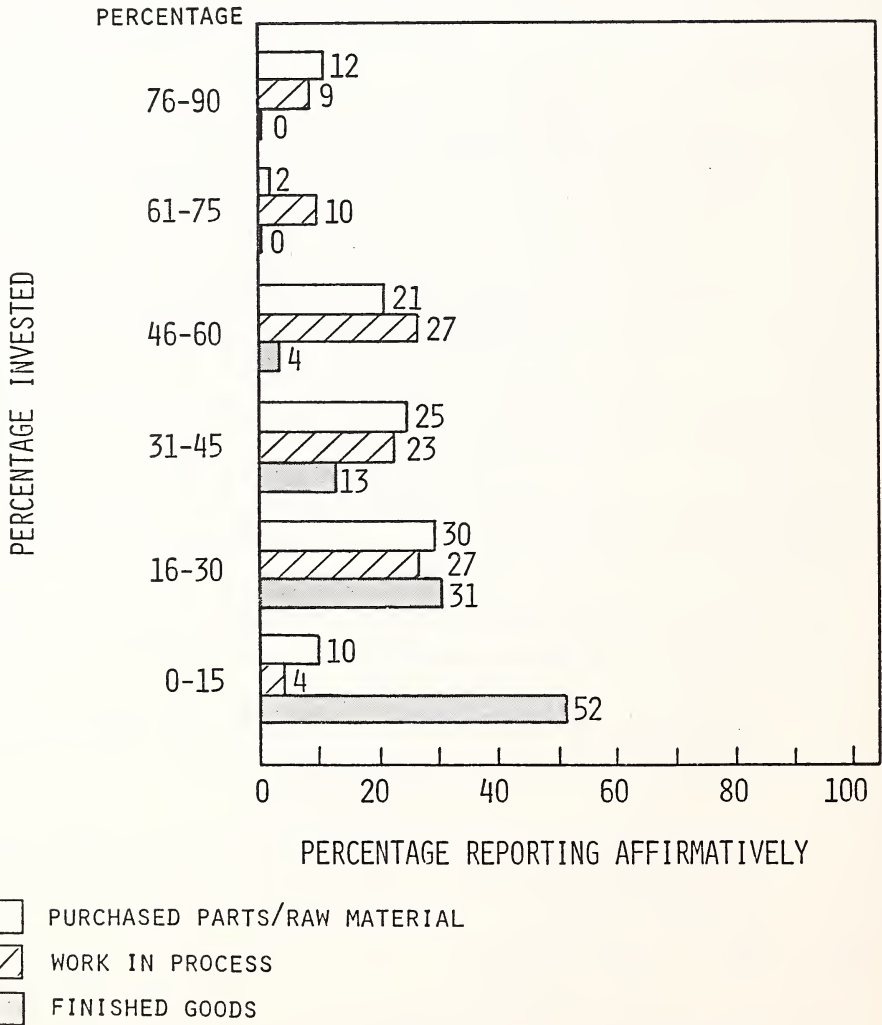
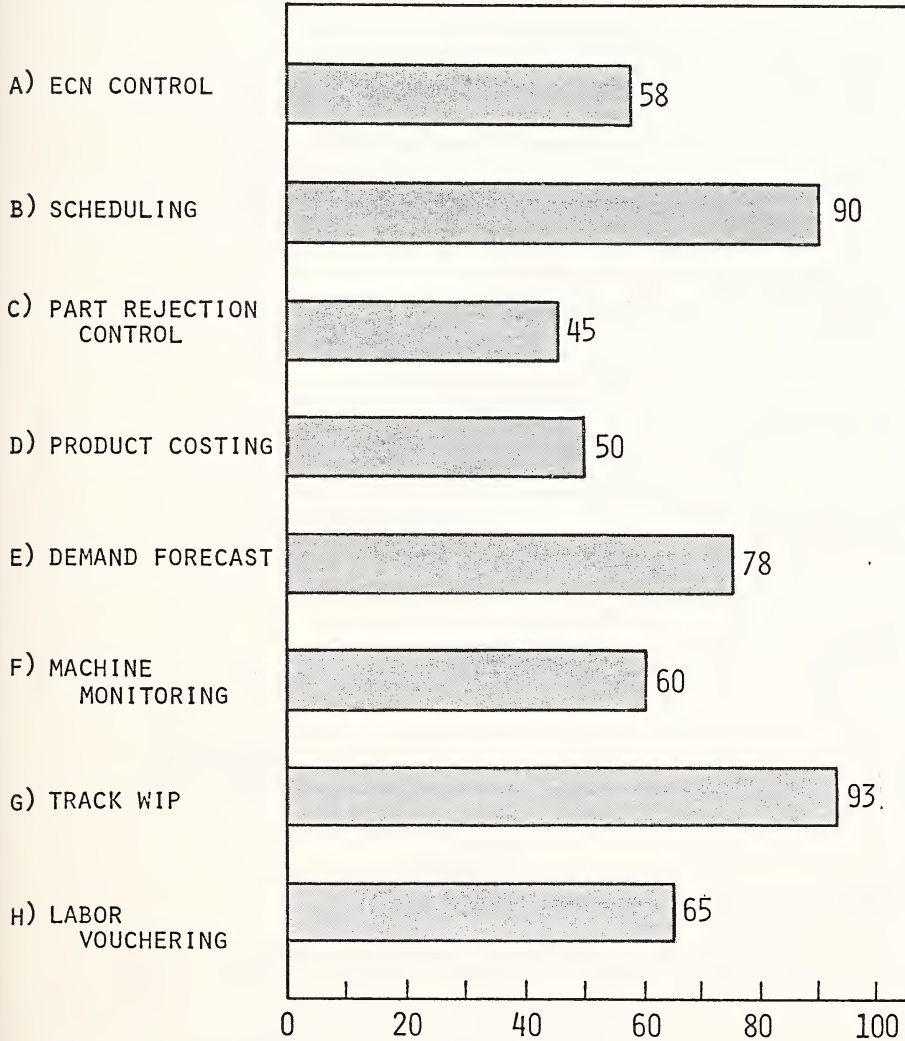


EXHIBIT III-6

RELATIVE IMPORTANCE*-MANUFACTURING

"HOT BUTTONS"
(52 RESPONSES)



* IMPORTANCE = $\frac{\sum (5-RATING) \times 25}{N}$

□ 1
■ 2

EXHIBIT III-7

MANUFACTURING "HOT BUTTONS" (52 RESPONSES)

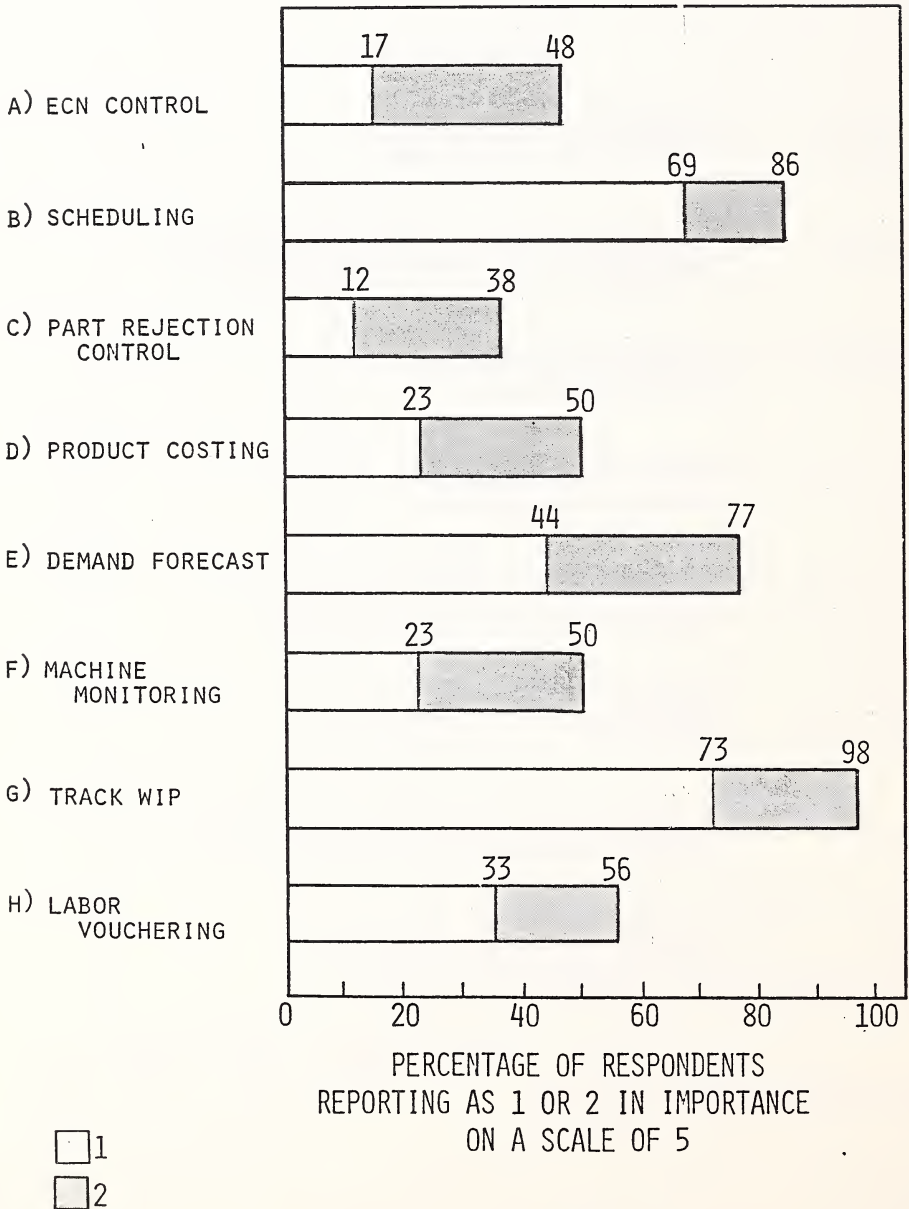
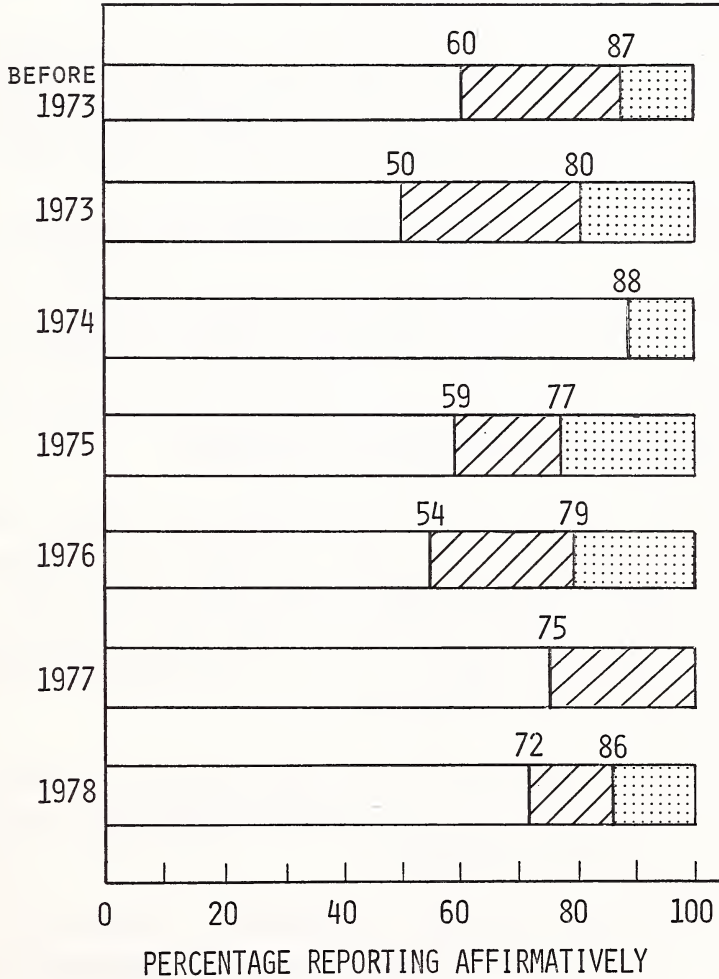


EXHIBIT III-9

PLANNING AND CONTROL SYSTEMS INSTALLED



☐ PLANNING
☒ F.D.C.
☒ STATUS REPORTING

- Very few reported having a vendor's turnkey system installed; with considerable evidence of "home-grown" or hybrid installations.
- As shown in Exhibit III-10, respondents are most familiar with the use of prepunched tickets as part of a "traveler" for collecting manufacturing data, closely followed by manual techniques:
 - About one-third of those responding used special or general purpose terminals. This data entry technique will increase in use as price/performance and ease of operator interface continues to improve.
 - Wands or sensor counters were not reported as being used.
 - Of significance is the finding that less than half of the interviewees believed that the techniques currently used are adequate.

E. EVALUATION OF HMS-80 PRODUCT CONCEPT

- Exhibits III-11 and III-12 show top ratings going to "status reporting," "upstream" interfacing, and "intradepartment communications" as the most desirable features of the HMS-80. In fact, the only element having less than an "importance factor" of 50 was the interfacing with other automation activities; (e.g., CNC, CAD, etc.).
 - All seven (Exhibit III-12a through -12g) plant management and control elements of the system received a combined rating for 1 and 2 (on a scale of 5), of over 65%.
 - Status reporting, intradepartment communications, "upstream" interfacing, and simple shop floor control were rated "1" by over 50% of the respondents.

EXHIBIT III-10

WHICH OF THE FOLLOWING TECHNIQUES DO YOU USE TO COLLECT DATA FROM MANUFACTURING? (CHECK APPROPRIATELY)

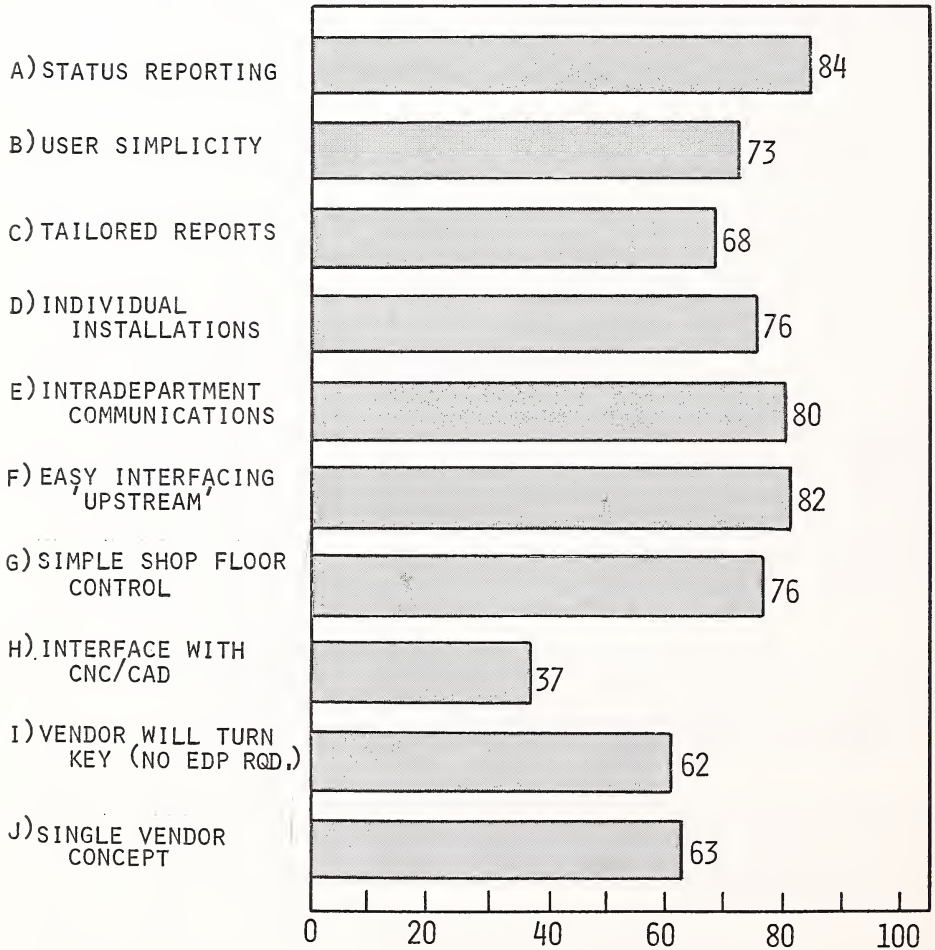
WHAT TYPE OF DATA IS COLLECTED?

METHOD	LABOR/ JOB	LOT NO. & QTY.	OTHER
A) PREPUNCHED TICKET WITH "TRAVELER" AND OPERATER ADDING QUANTITY, FI- NAL KEYPUNCH AND COMPUTER ENTRY BATCHED ON LARGE COMPUTER.	22	26	0
B) MANUAL RECORDS (TALLY SHEETS, ETC.) ARE MAINTAINED BY OPERATORS AND CLERICAL PERSONNEL.	23	21	1
C) SPECIAL PURPOSE TERMINAL DESIGNED TO FACILITATE SHOP FLOOR ENTRY (E.G., BADGE READER, CARD READER, KEY PAD, INPUT UNIT, ETC.)	16	16	0
D) GENERAL PURPOSE DATA TERMINAL (E.G., TERMINET, KEYBOARDS WITH CRT, ETC.)	5	10	5
E) WANDS (OCR OR MICR) (WOULD YOU USE?)	0	0	0
F) SENSOR OR COUNTER REQUIRING NO OPERATOR INVOLVEMENT.	2	1	0
G) OTHER (DESCRIBE)			

ARE THESE TECHNIQUES ADEQUATE IN TERMS OF TIMELINESS, ACCURACY,
AND EASE OF OPERATOR USE? YES 13 NO 24

EXHIBIT III-11

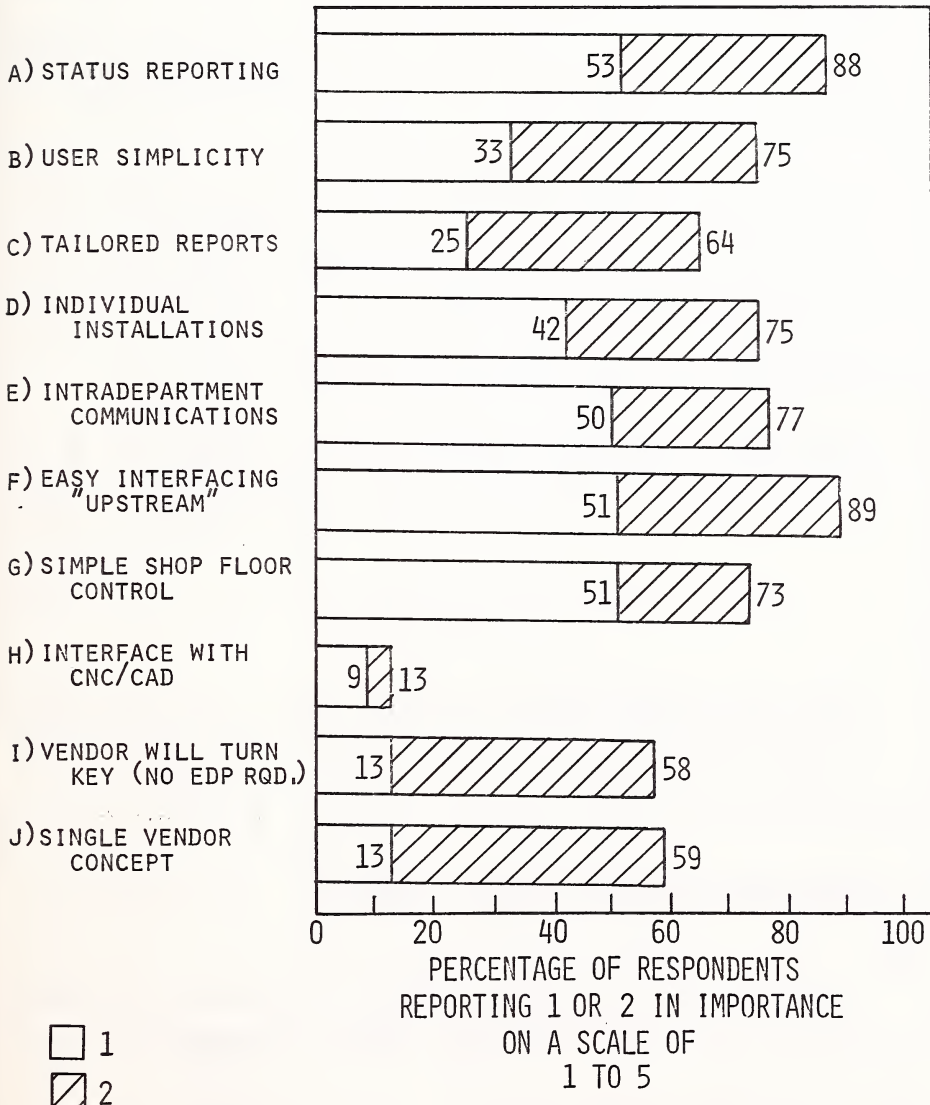
RELATIVE IMPORTANCE*-EVALUATION OF HMS-80 PRINCIPAL FEATURES BY RESPONDENTS (47 RESPONSES)



$$* \text{IMPORTANCE} = \frac{\sum (5 - \text{RATING}) \times 25}{N}$$

EXHIBIT III-12

EVALUATION OF HMS-80 BY RESPONDENTS (48 RESPONSES)



- As shown in Exhibit III-13, there appears to be little pattern in the degree of interest of the HMS-80 features, as expressed by the high versus low propensity SIC groups. The high propensity groups seem to have a higher purchase commitment in the short term (24 months). It is important to note that the price for a standalone application module becomes attractive at the \$45-55,000 level.
- Also, respondents report 70-100% probability of installing such a system in the 24-36 month time frame.
- Less than 20% of those interviewed would respond to questions about probabilities of spending for a total system from \$182,000 for controlling a 10,000 square foot plant to \$964,000 for a 200,000 square foot plant. When pressed, respondents indicated they might spend from 20-50% of the stipulated price per system with a 67% probability. These findings reinforce the belief that the system would be purchased on a one-at-a-time basis.
- Consideration of the HMS-80 importance as a management tool by the respondents indicates "anticipating stock outs" of greatest value (Exhibits III-14 and III-15), with part availability and resource planning following.
 - More than 75% rated these factors as 1 or 2 in importance on a scale of 5.
- Almost half (48%) of those interviewed rated "inventory control and investment" as "1" as a useful tool despite this factor being of less interest by those involved in government controlled expense reimbursement programs.

F. USERS' EVALUATION OF PRODUCT OPTIONS

- Over 50% of those interviewed rated CRTs "1" on a scale of 5 as the preferred method of receiving data output (Exhibit III-16). Of less interest were paper

EXHIBIT III-13

COMPARISON OF RESPONDENT PROPENSITY GROUPS TOWARD ACCEPTANCE OF HMS-80

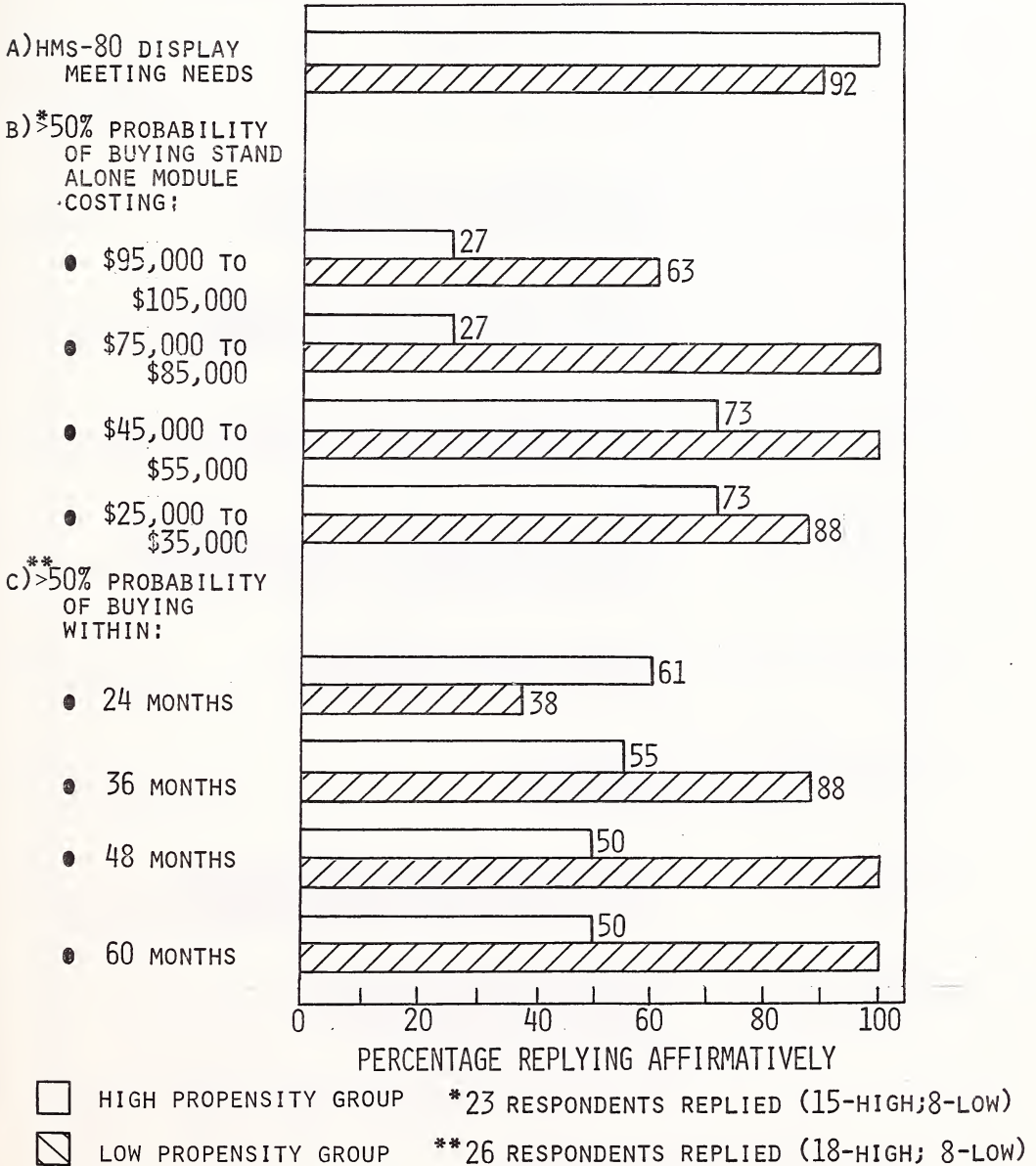
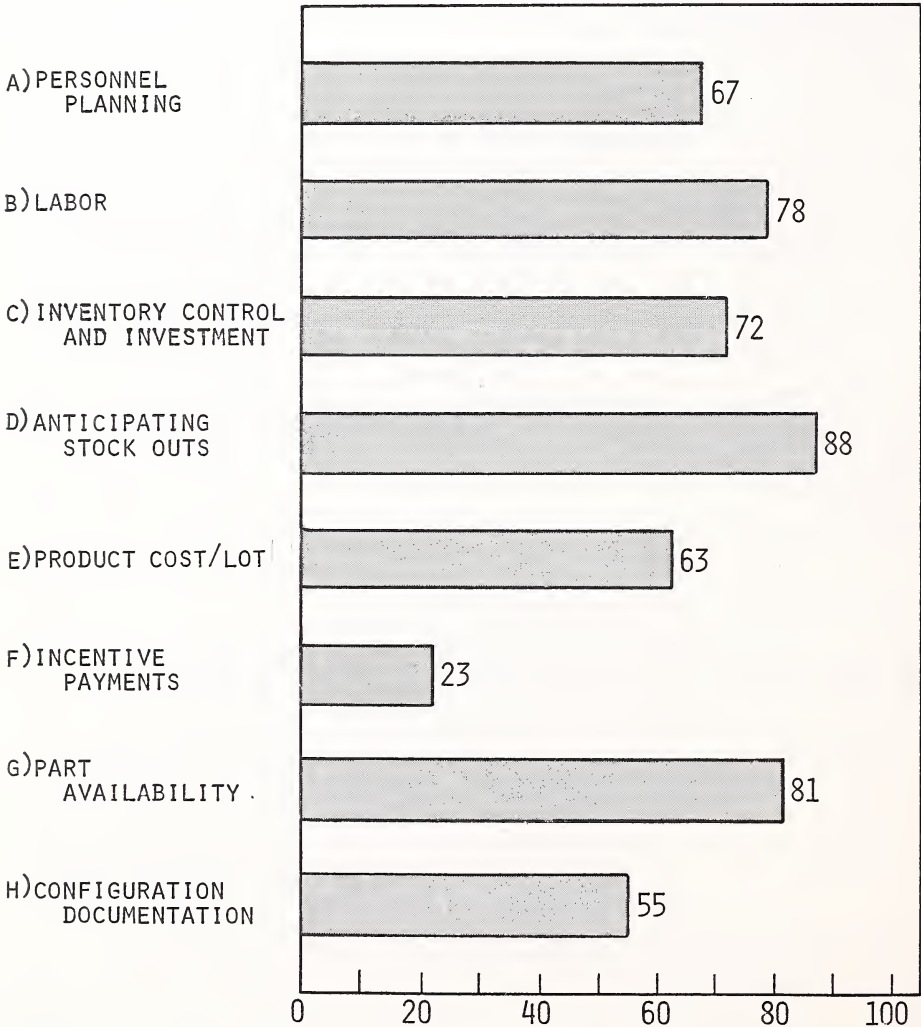


EXHIBIT III-14

RELATIVE IMPORTANCE*-EVALUATION OF HMS-80 MANAGEMENT TOOL (48 RESPONSES)



$$* \text{IMPORTANCE} = \frac{\sum (5 - \text{RATING}) \times 25}{N}$$

N

EXHIBIT III-15

THE IMPORTANCE TO THE RESPONDENT OF THE
FOLLOWING HMS-80 FEATURES:

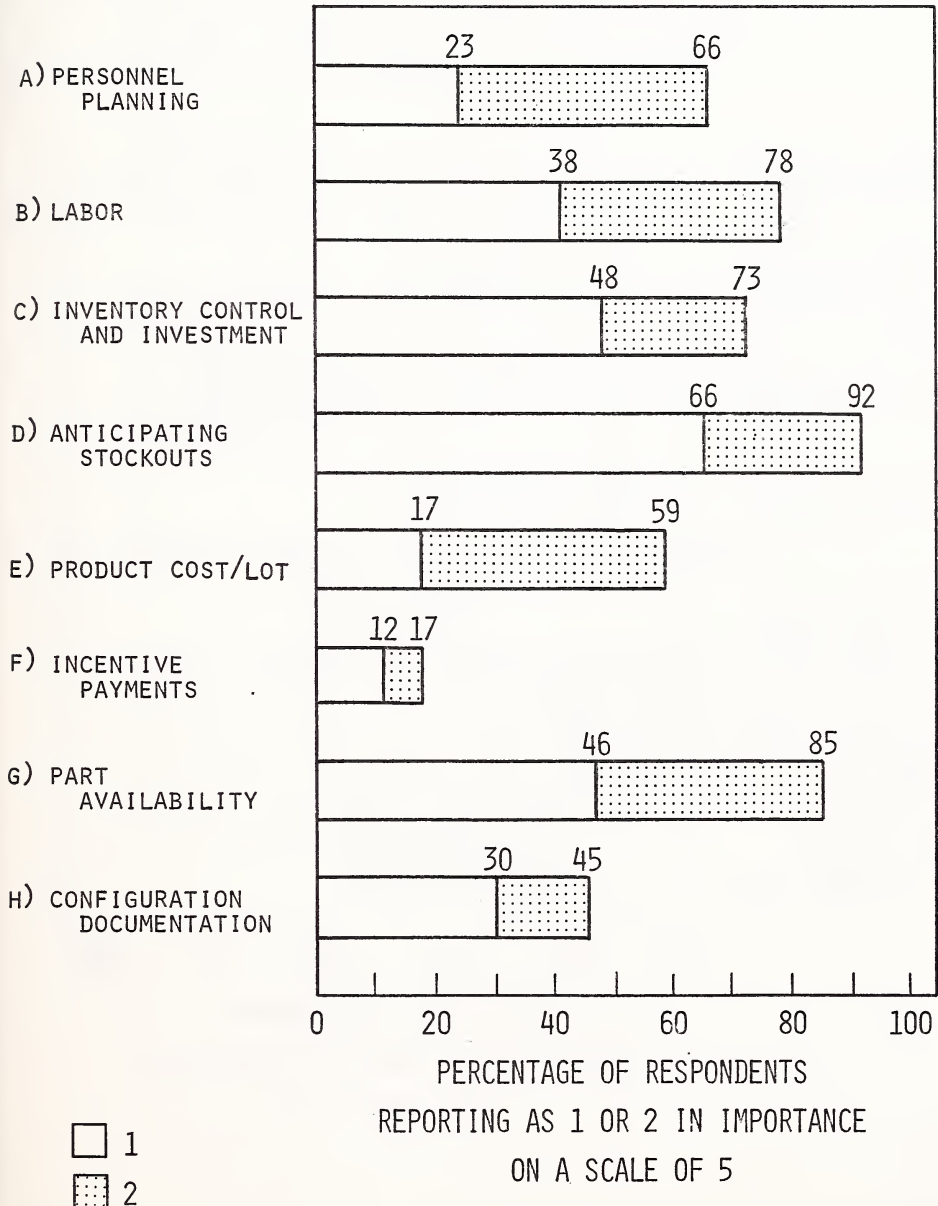
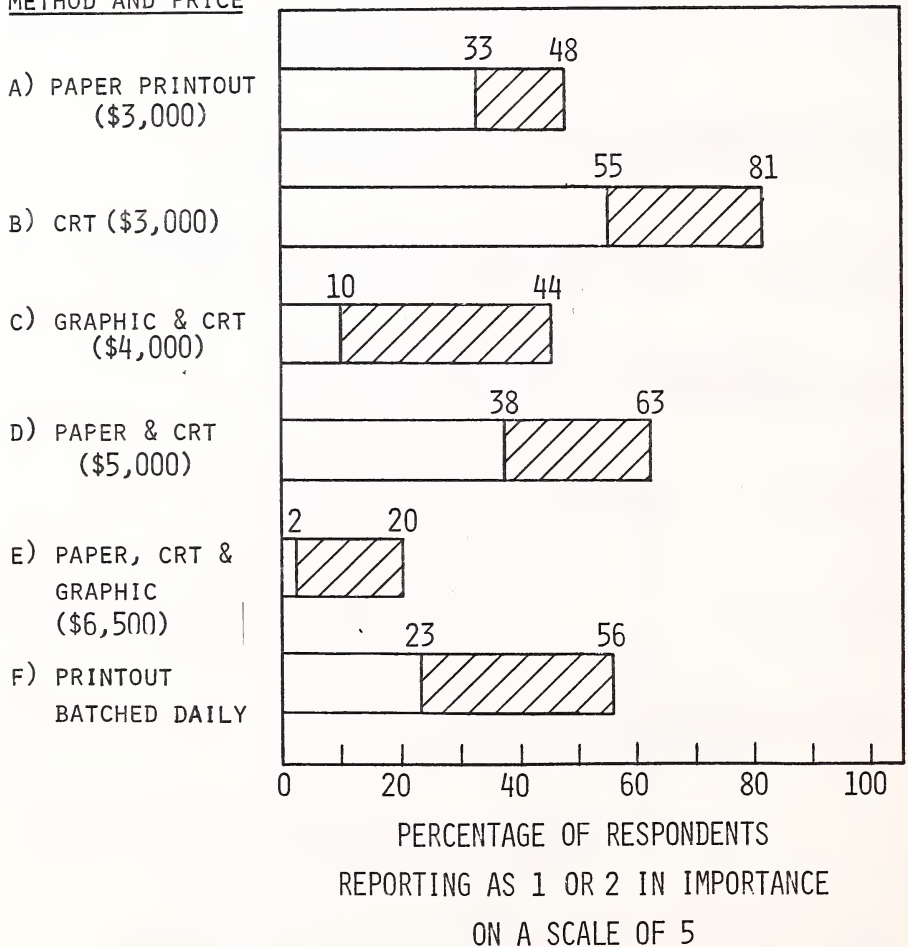


EXHIBIT III-16

PREFERRED METHODS FOR RECEIVING DATA OUTPUT AT SPECIFIED PRICES AS REPORTED BY RESPONDENTS (42 RESPONSES)

METHOD AND PRICE



- ☐ 1
☒ 2

printouts, graphic displays, or a combination of the above for a proportionately higher price.

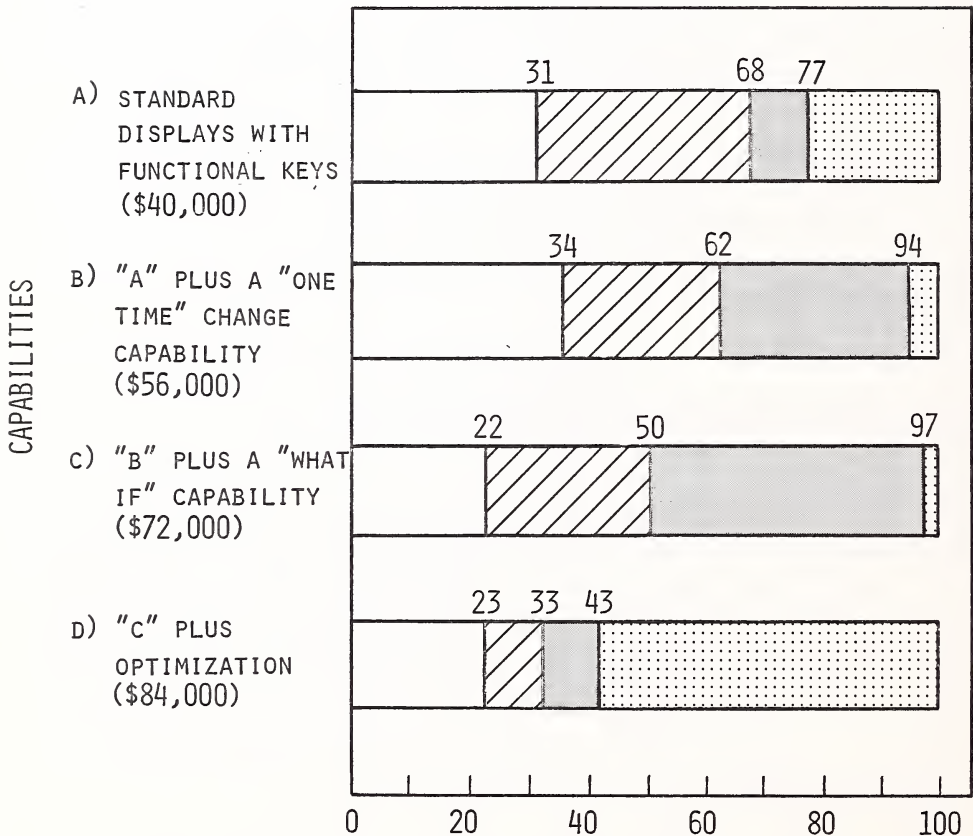
- When asked for their preferences concerning status reporting or inquiry reporting, respondents preferred a display with ability to "one-time" adjust (\$56,000) or standard display systems (\$40,000), as shown in Exhibit III-17.
- Respondents reported that they preferred applications development be performed by a vendor rather than through the in-house EDP staff, even though the anticipated cost would be about 20% higher (Exhibit III-18).
- As shown in Exhibit III-19, over 75% of those interviewed rated high (1 or 2) on a scale of 5, the desire for the vendor to configure application software requirements, user training and application software and maintenance. Of less interest were all system design and development and communications installations.

G. PRODUCT EVALUATION AND SELECTION PROCEDURE

- Exhibit III-20 shows that a member of production or materials management in conjunction with the EDP manager are the key players involved in the product initiation and justification process. After virtually every member of the manufacturing management team taking some part in the evaluation procedure, final approval usually rests with the senior manager at the establishment (or corporate) level.

EXHIBIT III-17

PREFERRED STATUS REPORTING/INQUIRY CAPABILITIES AS REPORTED BY RESPONDENTS (BASE SYSTEM: \$40,000) (35 RESPONSES)



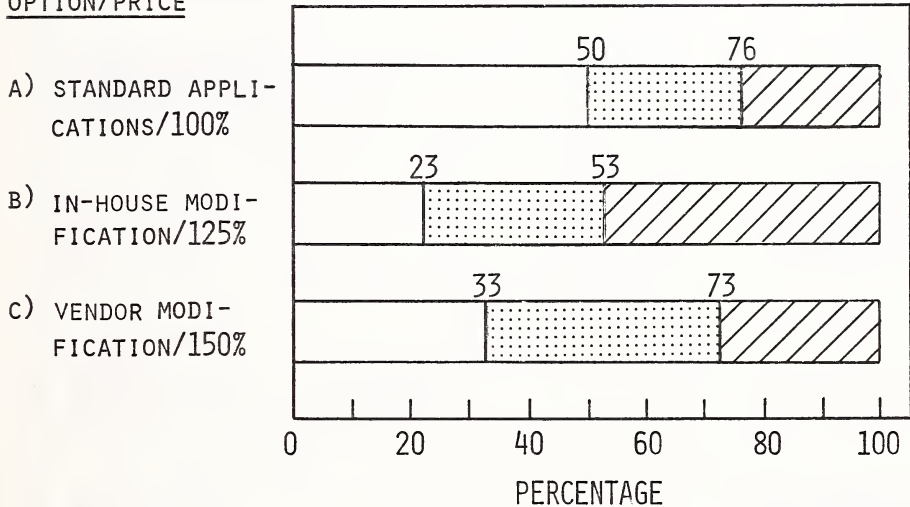
RANKINGS:

- ☐ = 1 (FIRST)
- ☒ = 2
- ☐ = 3
- ☐ = 4 (LAST)

EXHIBIT III-18

PREFERENCES FOR APPLICATIONS DEVELOPMENT AS REPORTED BY THE RESPONDENTS (43 RESPONSES)

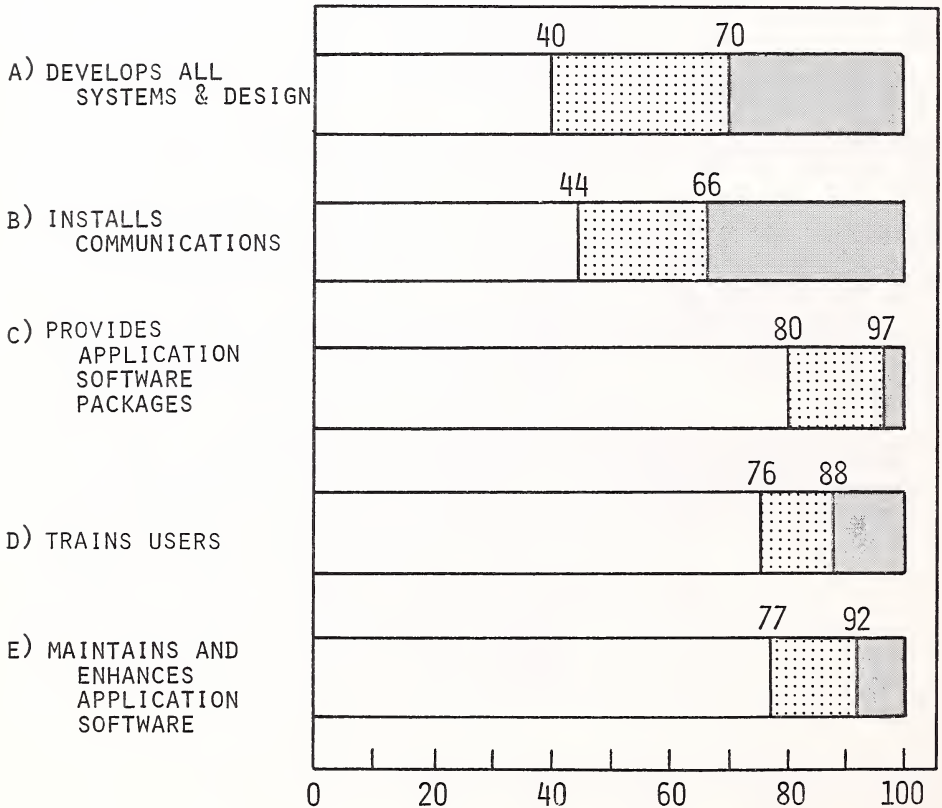
OPTION/PRICE



- ☐ 1ST RANKING
- ☒ 2ND RANKING
- ☒ 3RD RANKING

EXHIBT III-19

VENDOR SYSTEM INSTALLATION AND MAINTENANCE (41 RESPONSES)



PERCENTAGE OF RESPONDENTS' RATINGS IN IMPORTANCE

- ☐ HIGH (1,2)
- ☒ MEDIUM (3)
- ☐ LOW (4,5)

EXHIBIT III-20

WHO WAS OR WOULD BE INVOLVED IN THE PRODUCT EVALUATION?
(CHECK)

TITLE	INITIATE & JUSTIFY	WHO WOULD TAKE PART	FINALLY APPROVED
A) PRODUCTION MANAGER	24	33	4
B) PRODUCTION CONTROL MANAGER	23	34	3
C) MATERIAL CONTROL MANAGER	24	37	3
D) PURCHASING MANAGER	10	25	0
E) EDP MANAGER	29	46	7
F) MANUFACTURING ENGINEER- ING MANAGER	10	28	1
G) QUALITY CONTROL MANAGER	6	23	1
H) CONTROLLER	13	32	10
I) V.P. OPERATIONS	13	15	25
J) PRESIDENT /DIV.G.M.	6	6	38

H. RESPONDENTS' REACTIONS TOWARDS PLANT ENGINEERING OR CAD/CAM SYSTEMS

- Respondents were questioned as to the probability of them installing non-material control systems over the next 2-5 year period (Exhibit III-21). Relatively little enthusiasm was displayed for the plant engineering or CAD/CAM features (less than 50% showed interest in any but the CAD option over the 5 year period), probably because of the respondents' functional responsibilities being limited to materials or production control.
- Further evidence of the lack of respondents' enthusiasm for a CAD/CAM tie-in is displayed in Exhibit III-22. About 50% reported an existing interface for engineering change and bill of material control, which is critical for maintaining a materials requirement planning integrity.

I. MANUFACTURING PLANNING AND CONTROL INVESTMENT ALTERNATIVES

- Exhibit III-23 shows that respondents would allocate funds primarily for planning and scheduling for the first \$500,000 budget. For both the second and third \$500,000 budget allocations, about 50% would support factory data collection and status reporting equipment.
- For the total \$1.5 million budget, the approximate split of the allocations were:
 - Forecasting, planning, scheduling: 42%
 - FDC and status reporting: 42%
 - CAD,CAM: 16%

EXHIBIT III-21

RESPONDENT PRESENTLY HAS OR
WILL PROBABLY INSTALL
FOLLOWING SYSTEMS IN 2 AND 5 YEAR PERIOD
(35 RESPONSES)

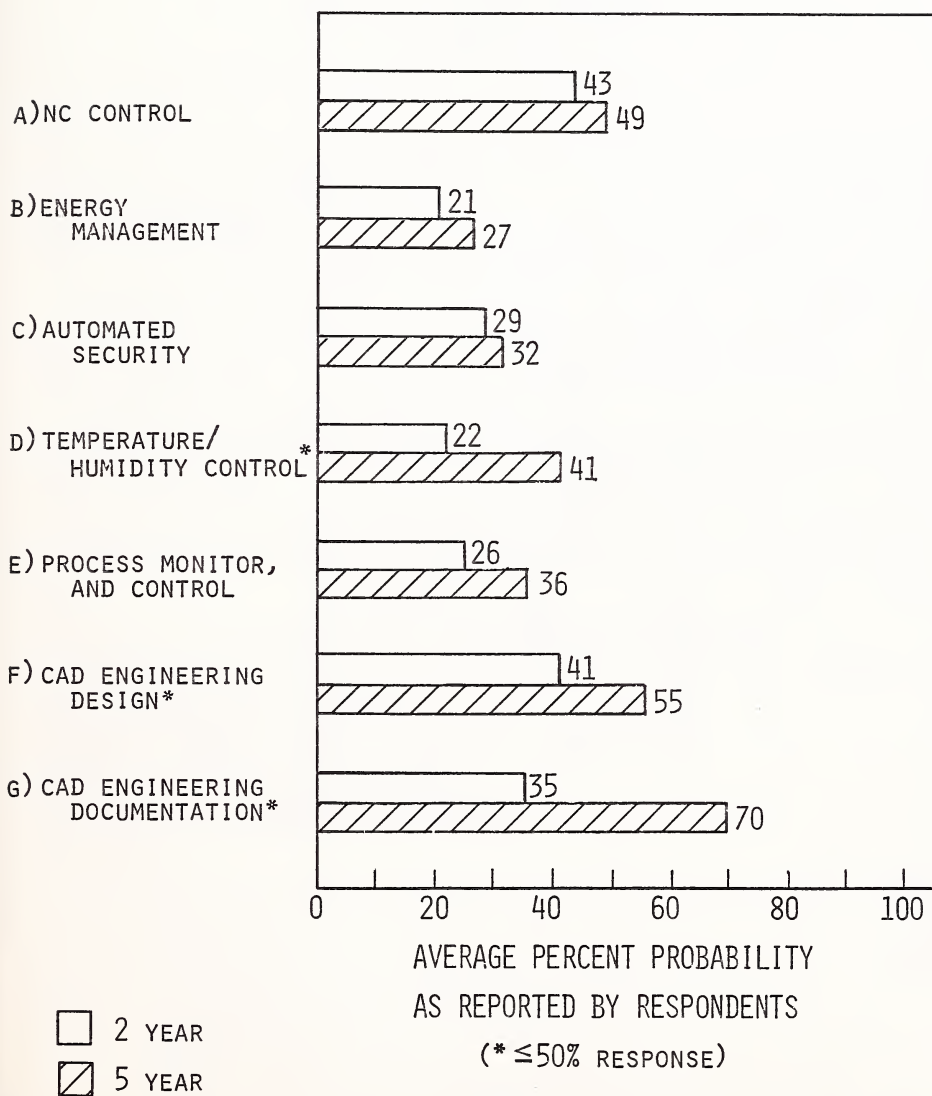
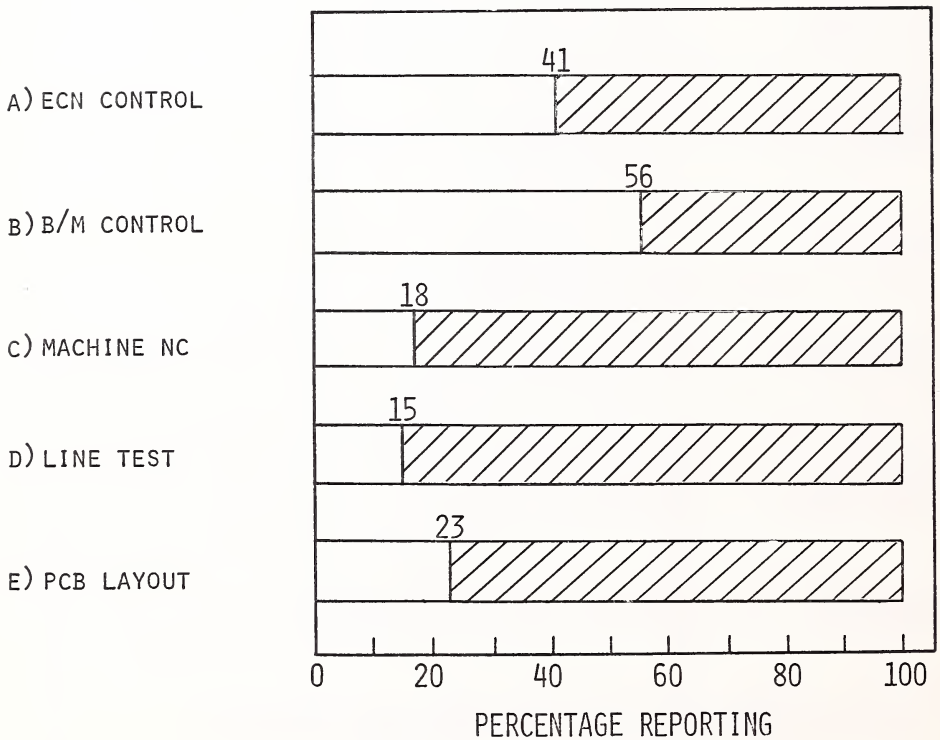


EXHIBIT III-22

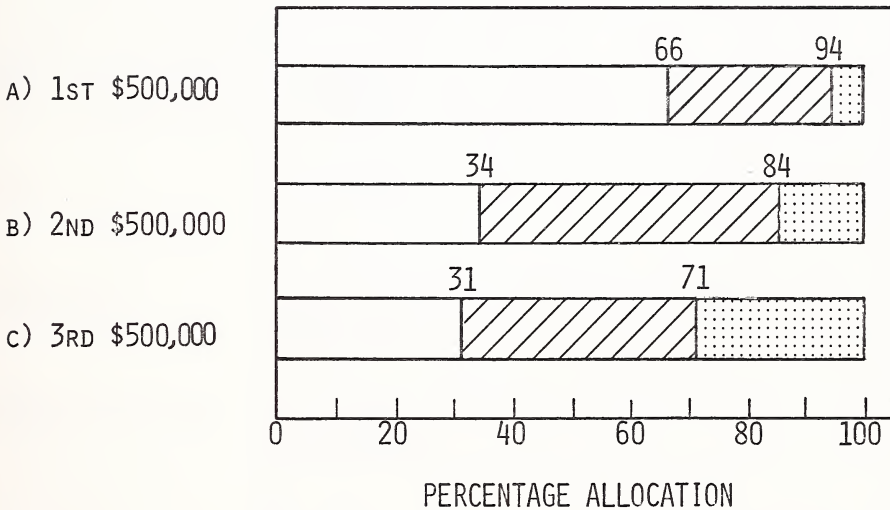
INTERFACING BETWEEN CAD/CAM AND MANUFACTURING AS REPORTED BY RESPONDENTS (43 RESPONSES)



☐ YES
☒ NO

EXHIBIT III-23

BUDGET ALLOCATIONS AS REPORTED BY RESPONDENTS FOR MANUFACTURING AND CONTROL APPLICATIONS (29 RESPONSES)



- ☐ FORECASTING, PLANNING,
SCHEDULING
- ☒ FDC AND STATUS REPORTING
- ☒ CAD, CAM

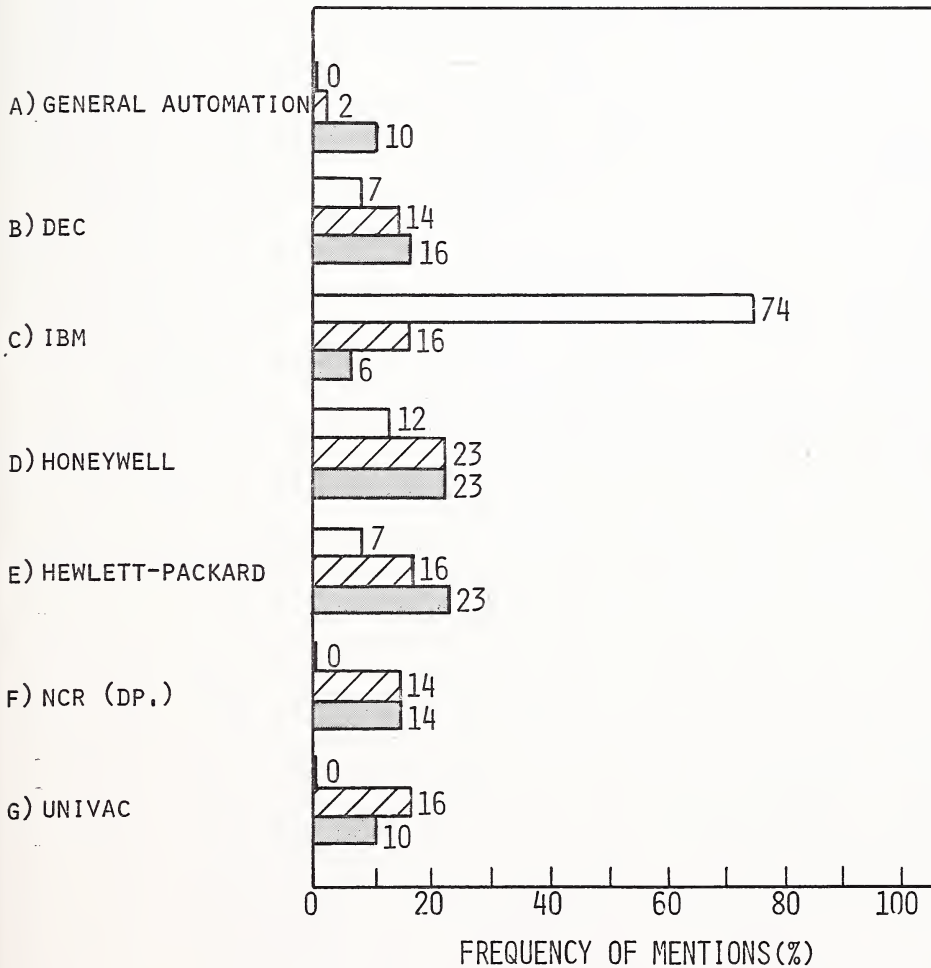
- Respondents believed that an average of 38% of an additional \$1 million capital budget would be spent on plant management and control equipment, and 62% on other investment alternatives.

J. EVALUATION OF POTENTIAL VENDORS

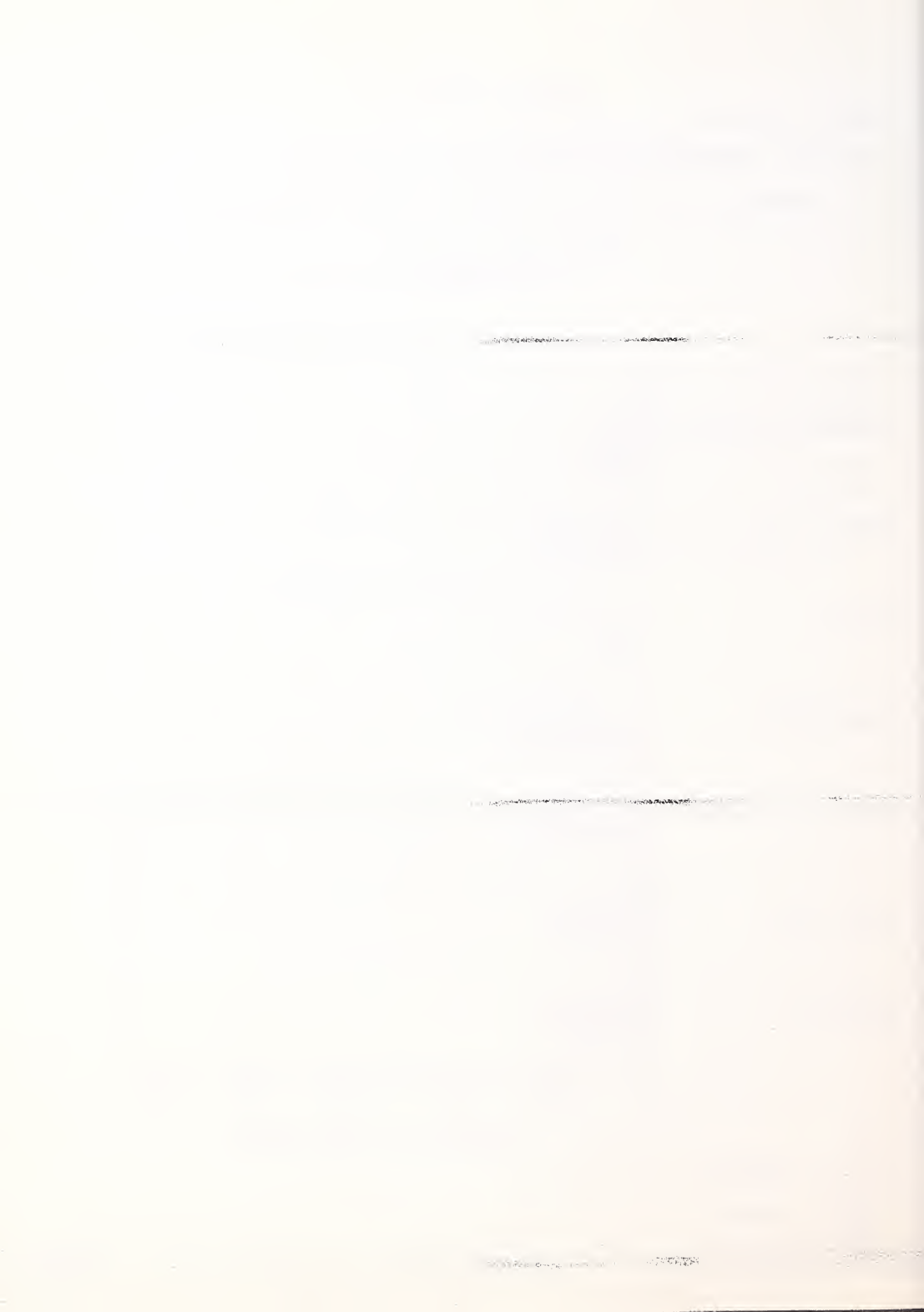
- When asked to rank the given companies as potential vendors of plant management and control systems, respondents overwhelmingly (74%) selected IBM as first choice (Exhibit III-24). Honeywell and Hewlett-Packard occupied the second and third popularity positions with Univac, DEC, NCR and Univac following in order. Only two respondents reported having a Honeywell mainframe, and their preference for Honeywell as a potential vendor of plant management and control system were ranked "2" and "5" on a scale of 1 to 7.

EXHIBIT III-24

RESPONDENTS' PREFERENCES OF FOLLOWING COMPANIES AS POTENTIAL VENDORS OF PLANT MANAGEMENT AND CONTROL SYSTEMS . (52 RESPONSES)



- ☐ 1ST CHOICE
- ☒ 2ND CHOICE
- ☐ 3RD CHOICE



IV MARKET PROJECTIONS FOR PLANT
MANAGEMENT AND CONTROL
SYSTEMS (U.S. ONLY)

IV MARKET PROJECTIONS FOR PLANT MANAGEMENT AND CONTROL SYSTEMS (U.S. ONLY)

A. DETERMINING MARKET POTENTIAL

- In attempting to structure the discrete manufacturing U.S. market for plant management and control systems, INPUT analyzed the potential as well as the actual demand for the product.
- INPUT estimated the number of employees within a discrete manufacturing establishment able to support the purchase of such a system in 1977 and 1982 (Exhibit IV-1). Assumptions were based upon the following:
 - Number of discrete manufacturing establishments in the U.S. (1975 County Business Patterns) using an average annual growth rate of 2% for 1977 and 1982 calculations.
 - Average number of employees per establishment size (500-999 and 1000+) were derived from the same source and using same method as for establishment population forecasts.
- INPUT assumed the number of employees required to substantiate the acquisition of such a system (1977 and 1982) based upon:

EXHIBIT IV-1

MARKET PROJECTIONS

POTENTIAL U.S. DISCRETE MANUFACTURING MARKET FOR PLANT MANAGEMENT AND CONTROL SYSTEMS (1977-1982)

	1977	1982
● ESTABLISHMENTS: 500-999		
EMPLOYEES:	1,870	2,070
ESTABLISHMENTS: 1,000+		
EMPLOYEES:	1,290	1,430
● EMPLOYEES: 500-999 (700 EMPL./EST.)	1,300,000	1,450,000
EMPLOYEES: 1000+ (3,000 EMPL./EST.)	3,900,000	4,300,000
TOTAL EMPLOYED:	5,200,000	5,750,000
● NUMBER OF EMPLOYEES/ SYSTEM:	300	150
● POTENTIAL MARKET (1,000'S OF UNITS/\$ MILLION)	17/870	38/1920

APPENDIX A: COMPANIES INTERVIEWED

APPENDIX B: USER QUESTIONNAIRE
(REVISED 5/12/78)

1. Total area: _____ square feet in this establishment.

2. Number of employees in this establishment:
 - a) In establishment _____
 - b) In manufacturing (total) _____
 - c) Direct labor only _____

3. Manufacturing output at this establishment:
 - a) Total number of products: _____
 - b) 1977 unit volume for largest product line: _____
 - c) Price of product:
 - i) Most expensive \$ _____
 - ii) Least expensive \$ _____
 - iii) Weighted average \$ _____

4. Product complexity
 - a) Total number of part numbers:
 - i) Purchased _____
 - ii) Fabricated _____
 - b) Number of part numbers per product:
 - i) Highest _____
 - ii) Lowest _____
 - iii) Weighted average _____
 - c) Average number of parts per product (part number x frequency):
 - i) Highest _____
 - ii) Lowest _____
 - iii) Weighted average _____

5. a) How many levels are there in your bill of materials? _____
- b) What percentage of total product explosions go to this level?

6. Process characteristics:
- a) What is your average order quantity:
- i) Fabrication of Class "A" parts: _____
- ii) Assembly: _____
- b) What percent are set-up actual hours to direct labor hours:
- i) Fabrication: _____ % Set-up
- ii) Assembly: _____ % Set-up
- c) On average, how much time (including queue, set-up, and run time) does the average job order spend at a single work station in:
- i) Fabrication: _____
- ii) Assembly: _____
- d) What is the production cycle time from release of order to assembly until time of final shipment: _____
7. Importance of quality control:
- a) How many (check) dedicated inspection test stations are there in your major product lines:

NUMBER	FABRICATION	ASSEMBLY
Zero		
≤ 2		
$3 \leq x \leq 5$		
≥ 6		

7. b. Do you have either parts or end-item product configuration management (documentation of fabrication and assembly for defective parts traceability):

Yes _____ No _____

If "yes," what proportion of your business: _____

8. Engineering change orders:

What is the average number of ECNs (affecting form and/or function):

- a) Monthly volume: i) Highest _____
 ii) Lowest _____
 iii) Average _____

- b) What percentage are classified "mandatory" (for immediate incorporation): _____ %

9. Do you have government contracts?

Yes _____ No _____

If "yes," what proportion of your business: _____

10. Inventory characteristics:

- a) What is your cost of carrying inventory: _____ %

- b) What percent of end items are built:

- i) To order _____ %
 ii) To stock _____ %
 100 %

- c) How does your inventory break down:

- i) Purchased parts and raw material _____ %
 ii) Work in process _____ %
 iii) Finished goods _____ %
 100 %

11. Manufacturing "hot buttons":

Rate the following activities (1 = critical, 5 = unimportant) as to their importance in contributing to smooth plant operations in your industry:

ACTIVITY	RATING	RANK 1s
a) <u>Labor vouchering</u> for pay records or product configuration management		
b) <u>Tracking work-in-process</u> for (1) minimizing inventory carrying cost (2) meeting customer delivery dates or (3) responding to resource unavailabilities		
c) <u>Machine monitoring</u>		
d) <u>Forecasting final (end item) demand</u>		
e) <u>Product costing</u> (direct and indirect) for accurate product pricing (marketing)		
f) <u>Control of split lots or lot rejection</u> resulting from Q. C. inspection		
g) <u>Production scheduling and requirements</u>		
h) <u>Maintaining current documentation on engineering change orders</u>		
i) Other		

12. How often must operating status be updated to satisfy production control and operating management requirements in the following activities? (check as required)

FUNCTION	ON-LINE	BY SHIFT	DAILY	WEEKLY
a) Receiving				
b) Purchasing				
c) Stores				
d) Fab or Machine Shop				
e) Assembly				
f) Q.C. (Receiving intermediate or final inspection)				
g) Shipping				
h) Other (describe)				

13. Current production planning and control techniques/practices:

How do you presently generate production requirements and control stock?
 (complete column A, check B and/or C)

ACTIVITY	(A) DATE INSTALLED	(B) IN-HOUSE DEVELOPMENT	(C) VENDOR NAME
a) Planning systems (e.g., MRP, scheduling, forecasting, etc.) i) ii) iii) iv) v)			
b) Factory data collection system i) ii)			
c) Status reporting system to compare actual against plans i) ii)			

14.

- a. Which of the following techniques do you use to collect data from manufacturing? (check appropriately)

What type of data is collected?

METHOD	LABOR/ JOB	LOT NO. & QTY.	OTHER
a) Prepunched ticket with "traveler" and operator adding quantity, final key-punch and computer entry batched on large computer.			
b) Manual records (tally sheets, etc.) are maintained by operators and clerical personnel			
c) Special purpose terminal designed to facilitate shop floor entry (e.g., badge reader, card reader, key pad input unit, etc.)			
d) General purpose data terminal (e.g., Terminet, keyboard w/CRT, etc.)			
e) Wands (OCR or MICR) (would you use?)			
f) Sensor or counter requiring no operator involvement.			
g) Other (describe)			

- b. Are these techniques adequate in terms of timeliness, accuracy, and ease of operator use? Yes ____ No ____ Why?

- c. What are your preferred techniques?

15. Evaluation of product "x"

Rank and rate (1=most and 5=least important) in importance to you the principal features of product "x"

Factor	Rating	Ranking of 1s
a. <u>Status report with automatic monitoring of plan vs. actual</u>		
b. <u>User simplicity</u> based upon functional keys to access "pyramid" reports		
c. <u>Reports initially tailored</u> to accept user's heading titles and field sizes		
d. One manufacturing activity/function can be implemented at a time on a <u>stand-alone basis</u>		
e. Capability for <u>direct intra-department/function communications</u> to obtain status information (e.g. production control to purchasing)		
f. Easily <u>interface</u> with <u>existing</u> "up-stream" manufacturing planning systems (manual or computer)		
g. Simple shop floor data collection devices requiring minimal operator input/interface to capture all information (e.g. single b badge and keypad quantity if any rejects		
h. Communications loop can interface/integrate other automation activities (e.g. CNC, CAD documentation, machine monitoring energy management, etc.)		
i. Vendor will " <u>turn-key</u> " and sell as machine tool or word processing not requiring complicated in-house EDP effort		
j. <u>Single vendor and single source of responsibility</u> concept for manufacturing control systems to be developed by vendor over next five years		

16. Would these displays satisfy your requirements for manufacturing status reports?

a) Yes _____ No _____

b) If no, why not?

What else would be required?

17. a) What is the probability that you would buy one of the stand-alone application modules (e.g., purchasing or shop floor control) for:

PRICE	PROBABILITY OF PURCHASE
\$95 - \$105,000	%
\$75 - 85,000	%
\$45 - 55,000	%
\$25 - 35,000	%

- b) If probability is less than 66% for \$45-55,000 price, what would be required to increase product's benefits?

18. Now consider building the total system. At what investment price would you be willing with 2/3's probability (etc.) to buy the total system if it could be built one application at a time?

Plant Management Control System Product for:	Approximate Price: Purchase/Monthly Lease		Probability of Purchase
a) \pm 10K sq. feet plant (\$182K, \$4500/mo)			67%
			34-66%
			33%
b) \pm 50K sq. feet plant (\$320K, \$8000/mo)			67%
			34-66%
			33%
c) \pm 100K sq. feet plant (\$550K, \$13,750/ mo)			67%
			34-66%
			33%
d) \pm 200K sq. feet plant (\$964K, \$24,000/ mo.)			67%
			34-66%
			33%

19. Respondent's evaluation of product "x" uses

Rate (1=high, 5=low) the importance to you of product "x" as a management tool in the following activities.

FACTOR	RATING	RANK ls
a) Personnel planning/ loading		
b) Labor		
c) Inventory investment and control		
d) Anticipating possible part shortages (purchasing, line, QC, etc.)		
e) Total product cost per lot (for pricing/marketing considerations)		
f) Incentive/payment programs		
g) Specific resource (part) availability		
h) Part/product configuration documentation (for govern- ment contracts, warranty or product liability)		
i) Other		

20. Output devices and techniques

When buying a system, rate your preferred method for receiving data output at specified prices for use by management or planning personnel (production control, foremen, purchasing, etc.) (1=highest by preference, 5=would not buy), and rank 1s.

Per Unit Price	Output	Rating	Rank 1s
\$3,000	a) Tabular reports on paper printout		
\$3,000	b) Tabular reports on CRT at user location		
\$4,000	c) Graphic displays as enhancement to either paper or CRT media		
\$5,000	d) Both paper and CRT tabular reports incorporated into single unit at user location		
\$6,500	e) Graphic displays or an enhancement to (d)		
Nominal by comparison	f) Printout batched daily per user request or schedule		
	f) Other		

21. What status reporting or information inquiry capability(ies) do you prefer and "why" (or "why not")? Assume the base price for the first capability "a" is \$40,000 per application module.

Rank Price
Relationship

	100%	a) <u>Exhaustive menu of standard displays requiring no inter-action with the computer other than keying functional keys which call forth specified reports.</u> Information in successive reports "pyramids" from over-view reports to more specific reports.
	140%	b) <u>User has flexibility for easily changing display format on a one-time basis.</u> Uses a less exhaustive set of standard "menu" reports but provides great flexibility in report format to meet user's specific information requirements. Requires no EDP knowledge but does require knowledge of data base and familiarity with possible manipulation routines. User must interact via a keyboard with English language computer prompts.
	180%	c) <u>"What if" analysis for decision testing</u> (e. g., if part "x" is robbed from Assembly "a" and provided to "b", what happens to scheduled completion dates for "a" and "b"?) Requires same user level familiarity as "b".
	210%	d) <u>"Optimization" analyses for selecting the "best" alternative from a specified set in terms of a specified criterion.</u> (e. g., identify which order of those scheduled for work center "ab" over the next two days can be robbed of part "x" without causing a delay in the latest scheduled completion date or overtime.

22. Applications development: What is your preference and "why" for product installation, implementation, and maintenance for the indicated "out of pocket" total cost comparisons? (1=most preferred)

Option	Price Relationship	Rank	Why
a) Purchase applications (meeting 80%+ needs using standard data formats) and hardware from single vendor (i. e. product "x").	100%		
b) Develop 95-100% of required application in-house tailored to your needs. Buy hardware only.	125%		
c) Purchase applications from software house, tailored to unique requirements (95% of needs); buying hardware from vendor.	150%		

23. System installation and maintenance: Rate the importance (1=high, 5=low) of the following.

FACTOR	RATING
a) Vendor develops <u>all</u> systems requirements and design specifications	
b) Installs communications system (i. e. strings wiring)	
c) Configure application software packages to meet user requirements	
d) Train users in product	
e) Provide maintenance and enhancements for applications software packages	

DECISION PROCESS/AUTHORITY

24. Who was or would be involved in the product evaluation? (check)

TITLE	INITIATE & JUSTIFY	WHO WOULD TAKE PART	FINALLY APPROVED
a) Production Manager			
b) Production Control Manager			
c) Material Control Manager			
d) Purchasing Manager			
e) EDP Manager			
f) Manufacturing Engineering Mgr			
g) Quality Control Manager			
h) Controller			
i) V.P. Operations			
j) President			

25. What department's budget (capital) covers this type of equipment?

Capital Authorization Limit (\$K)

a) Manufacturing Division

b) Material Control

c) Production Control

d) EDP

e) Other

26. What is the percent probability that you will install the following systems in the next 2 and 5 years?

SYSTEM	2 YEARS	5 YEARS
a) Computer N.C. Control	%	%
b) Energy Management	%	%
c) Automated Security Systems (video, sensors, etc.)	%	%
d) Temperature and Humidity Control	%	%
e) Process Monitors and Control	%	%
f) Other	%	%

27. Is there an interface between CAD/CAM and production or manufacturing, and describe and rank its importance (1 = highest, 5 = lowest) :

Factor	Y/N	If "Yes", Describe	Rank
a) ECN Control	Y ____ N ____		
b) B/M Control	Y ____ N ____		
c) Machine Tool N.C.	Y ____ N ____		
d) Line Test/QC	Y ____ N ____		
e) PCB Layout	Y ____ N ____		
f) Other			

28. Where (check) do you see the greatest economic pay-off from computer-aided design?

- a) Design simulation, interactive graphics, and automatic drafting ☐
- b) Automating the documentation interface with manufacturing ☐

Why?

29. What is the probability that CAD will be implemented at your establishment in the following timeframe?

	PROBABILITY IN 2 YEARS	PROBABILITY IN 5 YEARS
a) Engineering Design		
b) Engineering Documentation		
Why?		

30.

EVALUATION OF RELATIVE IMPORTANCE OF THREE GENERAL
MANUFACTURING PLANNING AND CONTROL APPLICATION AREAS

Under the assumptions specified below, how would you allocate monies among the three competing capabilities?

BUDGET ALLOCATION

	FIRST \$500K ASSUMPTIONS "A"	SECOND \$500K ASSUMPTIONS "B"	\$500K ASSUMPTIONS "C"
a) Forecasting, master scheduling, MRP, production scheduling, etc.			
b) Product "X" - factory data collection and status report inquiry (actual vs plan)			
c) Computer aided engineering design simulation, graphics, drafting, and documentation to manufacturing			

TOTAL

100%

100%

100%

ASSUMPTIONS "A"

1. Given budget increase of \$500K.

2. Expenditure of full \$500K in single area
would provide 100% of "state-of-the-art"
capability for that area.

3. Incremental investments can be made
effectively in each area (e.g., 10%
investment buys 10% capability).

4. You have nothing today.

ASSUMPTIONS "B"

1. Same as "A" except have already
spent first \$500K.

2. Budget increased by second \$500K.

ASSUMPTIONS "C"

1. Same as "A" except \$500
budget increase is on top
of current actual capa-
bilities (instead of
hypothetical).

31. If the general manager's budget were increased by \$1M how would it most likely be distributed between the type capabilities covered in this questionnaire and all other investment alternatives?

Production planning and control, CAD,
factory data collection, etc.

All other investment alternatives
(e.g., machine tools, maintenance
or facilities expenses, etc.)

TOTAL

100%

CORPORATE PREFERENCE/IMAGE

32. From your perception of the following companies, rank them as potential vendors of plant management and control systems that you would consider working with. (1 through 7)

Rank

a)	General Automation	
b)	Digital Equipment Corporation	
c)	IBM	
d)	Honeywell	
e)	Hewlett-Packard	
f)	Data Pathing/NCR	
g)	Univac	

ONE LAST PURCHASE EVALUATION

33. What is the probability of your installing such a system as Product "X"? (check)

Time Period	25%	25-49%	50-74%	75%
a) Within 24 Months				
b) Within 36 Months				
c) Within 48 Months				
d) Within 60 Months				

34. If you see no immediate benefit in the type system as described in Product "X", what capabilities and benefits are required to justify your consideration?

END

**APPENDIX C: SIC CODE INDUSTRY
CLASSIFICATIONS**

APPENDIX C: SIC CODE INDUSTRY DESIGNATIONS

3429	Hardware, not elsewhere classified (miscellaneous metal products)
3433	Heating equipment, except electric and warm air furnaces (including gas, oil and stoker fired equipment for automobile utilization of gaseous, liquid, and solid fuels)
3494	Valves and pipe fittings (except plumbers brass goods)
3452	Bolts, nuts, screws, rivets, and washers (formed and threaded wire goods and special industrial fasteners)
3523	Farm machinery and equipment
3531	Construction machinery and equipment
3532	Mining machinery and equipment (except oil field machinery and equipment)
3533	Oil field machinery and equipment (machinery used in oil and gas fields or drilling water wells)
3535	Conveyors and conveying equipment (passenger or freight elevator, dumb wait, and moving stairways)
3546	Power driven hand tools
3551	Food products machinery
3559	Special industry machinery, not elsewhere classified (i.e., smelting, refining, cement, incandescent lamp making)
3562	Ball and roller bearings
3563	Air and gas compressors
3621	Motors and generators (except starting motors)
3631	Household cooking equipment (includes electric and non-electric types)

- 3632 Household refrigerators and home and farm freezers
- 3639 Household appliances, not elsewhere classified
- 3641 Telephone and telegraph apparatus
- 3662 Radio and television transmitting, signaling and detection equipment and apparatus
- 3679 Electronic components, not elsewhere classified
- 3721 Aircraft (manufacturing and assembly of complete aircraft)
- 3728 Aircraft parts and auxiliary equipment, not elsewhere classified

